

1. In a network system that includes a multimedia source and a multimedia sink, the multimedia source transmitting a stream of multimedia packets to the multimedia sink over a plurality of heterogeneous networks, the heterogeneous networks including a plurality of variable delay networks, a method of performing constant delay communication of the stream of multimedia packets from the multimedia source over the heterogeneous networks to the multimedia sink even though one or more of the variable delay networks do not themselves provide for a common reckoning of time in the variable delay network, the method comprising the following:

establishing a common time reckoning in all of the variable delay networks that do not themselves provide for a common time reckoning;

emulating the plurality of variable delay networks as one or more constant delay networks using the specific common time reckonings present in the plurality of variable delay networks, wherein the heterogeneous networks as a whole emulates a constant delay network; and

transmitting a multimedia packet over the heterogeneous networks.

2. A method in accordance with claim 1, further comprising the following:

receiving the multimedia packet from a previous network in the heterogeneous networks;

as the multimedia packet transitions from the previous network to a next network in the heterogeneous networks, configuring the multimedia packet if necessary to conform with the requirements of the next network if the multimedia packet does not already conform with the requirements of the next network; and

transmitting the reconfigured multimedia packet onto the next network.

3. A method in accordance with Claim 2, further comprising:

repeating the act of receiving the multimedia packet from a previous network, the act of configuring the multimedia packet if necessary, and the act of transmitting the reconfigured multimedia packet onto the next network for each network transition as the multimedia packet traverses the heterogeneous networks from the multimedia source to the multimedia sink.

4. The method in accordance with Claim 2, wherein the next network is a variable delay network, wherein the act of configuring the multimedia packet if necessary comprises the following:

generate a time stamp that represents a time in accordance with a common time reckoning of the variable delay network; and  
including the time stamp in the multimedia packet.

5. The method in accordance with Claim 4, wherein the act of including the time stamp in the multimedia packet is performed by the link layer.

6. The method in accordance with Claim 4, wherein the act of including the time stamp in the multimedia packet comprises the following:

including the time stamp in the multimedia packet before control of the multimedia packet transfers to the link layer associated with the next network.

1           7.       The method in accordance with Claim 6, wherein the act of including the  
2 time stamp in the multimedia packet before control of the multimedia packet transfers to  
3 the link layer comprises the following:

4                   an application layer including the time stamp in the multimedia packet.  
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1           8.     In a variable delay network that includes a transmitter and a receiver, a  
2 transmitter application associated with the transmitter configured to transmit a stream of  
3 multimedia packets through a transmitter link layer controller, over the variable delay  
4 network, through a receiver link layer controller to a receiver application associated with  
5 the receiver, the transmitter link layer controller having an undedicated variable delay  
6 interface with the transmitter application, the transmitter link layer controller and the  
7 receiver link layer controller being substantially synchronized in accordance with a  
8 common network time base, a method of the transmitter link layer controller emulating a  
9 constant delay network over the variable delay network despite the undedicated variable  
10 delay interface, the method comprising the following:

11                 receiving a first multimedia packet from the transmitter application, the first  
12 multimedia packet including a first transmitter application time stamp, which  
13 represents the relative time that the information in the first multimedia packet  
14 should be rendered by the receiver application in accordance with a transmitter  
15 application time base;

16                 including in the first multimedia packet a first network time stamp, which  
17 represents the relative time that the information in the first multimedia packet  
18 should be rendered by the receiver application in accordance with the common  
19 network time base;

20                 receiving data representing a frequency of the transmitter application time  
21 base;

22                 receiving a second multimedia packet from the transmitter application, the  
23 second multimedia packet including a second transmitter application time stamp,  
24 which represents the relative time that the information in the second multimedia

1 packet should be rendered by the receiver application in accordance with the  
2 transmitter application time base;

3 calculating a second network time stamp representing the relative time that  
4 the information in the second multimedia packet should be rendered by the receiver  
5 application in accordance with the common network time base, the calculation  
6 based on the first transmitter application time stamp, the second transmitter  
7 application time stamp, the frequency, and the first network time stamp;

8 including the second network time stamp in the second multimedia packet;

9 and

10 dispatching the second multimedia packet to the receiver application.  
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12 9. A method in accordance with Claim 8, where the variable delay network is  
13 an IEEE 1394 compliant network, the transmitter link layer controller comprises an OHCI  
14 link layer controller, and the undedicated variable delay interface comprises a PCI  
15 interface.  
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17 10. A method in accordance with Claim 8, wherein including the second  
18 network time stamp in the second multimedia packet is performed in accordance with the  
19 IEC 61883 protocol.  
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1           11. A computer program product for use in a variable delay network that  
2 includes a transmitter and a receiver, a transmitter application associated with the  
3 transmitter configured to transmit a stream of multimedia packets through a transmitter  
4 link layer controller, over the variable delay network, through a receiver link layer  
5 controller to a receiver application associated with the receiver, the transmitter link layer  
6 controller having an undedicated variable delay interface with the transmitter application,  
7 the transmitter link layer controller and the receiver link layer controller being substantially  
8 synchronized in accordance with a common network time base, the computer program  
9 product for implementing a method of the transmitter link layer controller emulating a  
10 constant delay network over the variable delay network despite the undedicated variable  
11 delay interface, the computer program product comprising computer-readable medium  
12 having stored thereon computer-executable instructions that, when executed by one or  
13 more processor, cause the transmitter link layer controller to perform the following:

14                 detecting the receipt of a first multimedia packet from the transmitter  
15 application, the first multimedia packet including a first transmitter application time  
16 stamp, which represents the relative time that the information in the first  
17 multimedia packet should be rendered by the receiver application in accordance  
18 with a transmitter application time base;

19                 including in the first multimedia packet a first network time stamp, which  
20 represents the relative time that the information in the first multimedia packet  
21 should be rendered by the receiver application in accordance with the common  
22 network time base;

23                 detecting the receipt of data representing a frequency of the transmitter  
24 application time base;

1 detecting the receipt of a second multimedia packet from the transmitter  
2 application, the second multimedia packet including a second transmitter  
3 application time stamp, which represents the relative time that the information in  
4 the second multimedia packet should be rendered by the receiver application in  
5 accordance with the transmitter application time base;

6 calculating a second network time stamp representing the relative time that  
7 the information in the second multimedia packet should be rendered by the receiver  
8 application in accordance with the common network time base, the calculation  
9 based on the first transmitter application time stamp, the second transmitter  
10 application time stamp, the frequency, and the first network time stamp;

11 including the second network time stamp in the second multimedia packet;  
12 and

13 causing the second multimedia packet to be dispatched to the receiver  
14 application.

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16 12. A computer program product in accordance with Claim 11, wherein the  
17 computer-readable medium is one or more physical storage media.

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19 13. A computer program product in accordance with Claim 11, wherein the  
20 variable delay network is an IEEE 1394 compliant network, the transmitter link layer  
21 controller comprises an OHCI link layer controller, and the undedicated variable delay  
22 interface comprises a PCI interface.

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1           14.    A computer program product in accordance with Claim 11, wherein the  
2 computer-executable instructions for including the second network time stamp in the  
3 second multimedia packet is executed in accordance with the IEC 61883-x protocol.  
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1           15.    In a variable delay network that includes a transmitter and a receiver, a  
2 transmitter application associated with the transmitter configured to transmit a stream of  
3 multimedia packets through a transmitter link layer controller, over the variable delay  
4 network, through a receiver link layer controller to a receiver application associated with  
5 the receiver, a method of the transmitter emulating a constant delay network over the  
6 variable delay network, the method comprising the following:

7                   storing a transmitter application time base in a register;

8                   periodically transmitting the transmitter application time base to one or  
9 more other devices in the variable delay network;

10                  including a transmitter application time stamp in a multimedia packet, the  
11 transmitter application time stamp representing the relative time that the  
12 information in the multimedia packet should be rendered by the receiver  
13 application; and

14                  dispatching the multimedia packet to the receiver application.

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16           16.    The method in accordance with Claim 15, wherein the variable delay  
17 network is an IEEE 802.11 compliant network.  
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1           17. A computer program product for use in a variable delay network that  
2 includes a transmitter and a receiver, a transmitter application associated with the  
3 transmitter configured to transmit a stream of multimedia packets through a transmitter  
4 link layer controller, over the variable delay network, through a receiver link layer  
5 controller to a receiver application associated with the receiver, the computer program  
6 product for implementing a method of the transmitter emulating a constant delay network  
7 over the variable delay network, the computer program product comprising a computer  
8 readable medium having stored thereon computer-executable instructions for performing  
9 the following:

10                   causing a transmitter application time base to be stored in a register;  
11                   periodically transmitting the transmitter application time base to one or  
12 more other devices in the variable delay network;  
13                   including a transmitter application time stamp in a multimedia packet, the  
14 transmitter application time stamp representing the relative time that the  
15 information in the multimedia packet should be rendered by the receiver  
16 application; and  
17                   causing the multimedia packet to be dispatched to the receiver application.

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19           18. A computer program product in accordance with Claim 17, wherein the  
20 computer-readable medium is one or more physical storage media.

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22           19. A computer program product in accordance with Claim 17, wherein the  
23 variable delay network is an IEEE 802.11 compliant network.  
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